SANDIA LABNEWS
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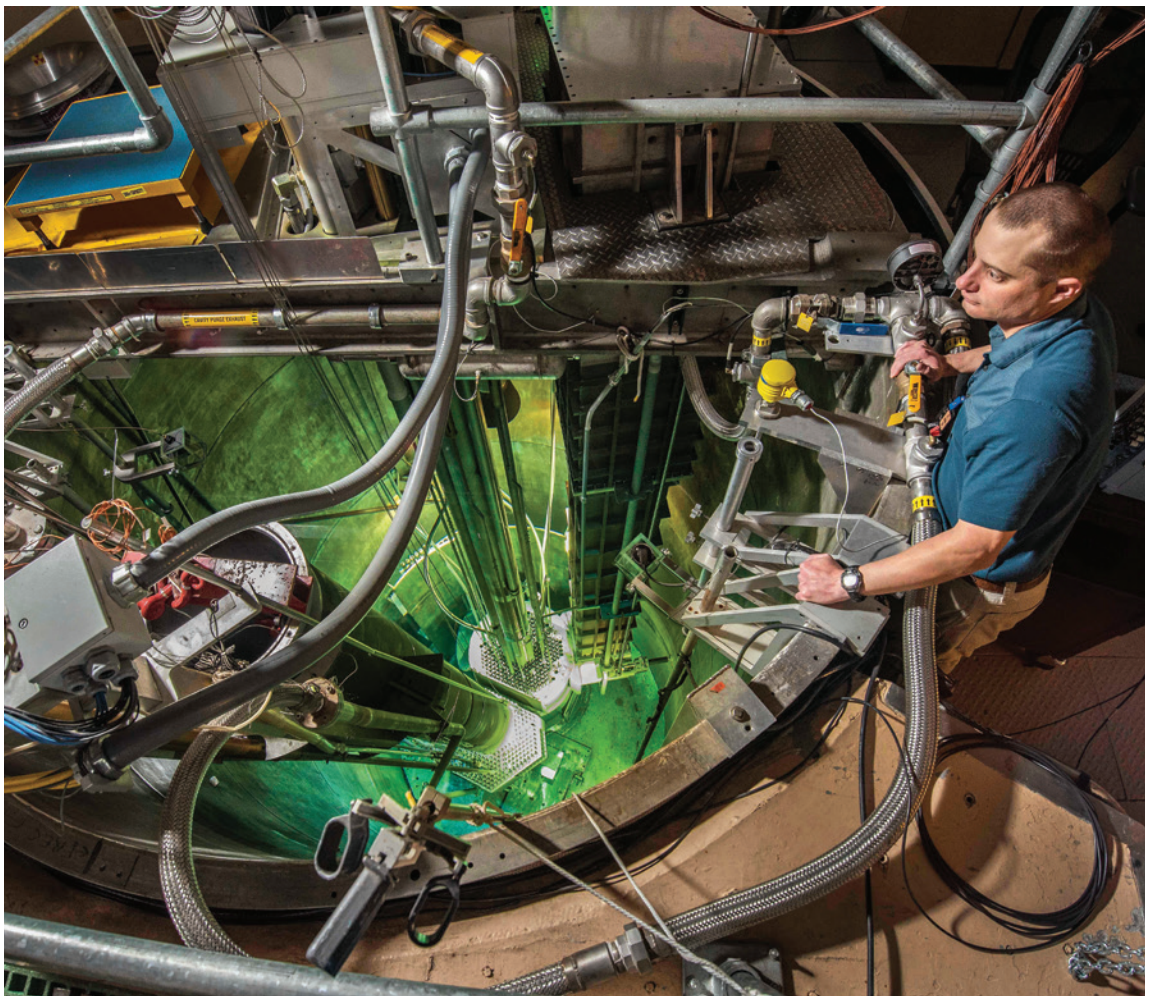
Society of Women Engineers awards Page 4

Building a medical-isotope producing reactor

Sandia partnerships, technologies win four regional tech transfer awards



IMPORTANT ISOTOPE — Researcher John Hall surveys Sandia's Annular Core Research Reactor, where scientists discovered a way to make medical isotopes. The concept was licensed to Eden Radioisotopes LLC, and the effort recently earned an award from the Federal Laboratories Consortium. **Photo by Randy Montoya**

By ***Manette Newbold Fisher***

A New Mexico company secured funding this year and located 240 acres of land in the southeastern corner of the state to build a small reactor that exclusively will produce medical isotopes. The concept was developed and licensed by Sandia to help establish a stable domestic supply of medical isotopes, which are made with low-enriched uranium and are used to help diagnose a number of diseases.

Adjustments to the license made by Sandia earlier this year helped Eden Radioisotopes LLC secure funding. Eden's chief operations officer Chris Wagner said he expects to break ground on the facility once all other licensing and agreements have been reached.

This effort earned a regional Excellence in Technology Transfer Award from the Federal Laboratory Consortium, which recognizes federal laboratories and their partners for outstanding work to develop and commercialize innovative technologies.

Medical isotopes used in 40 million procedures each year

Medical isotopes are used around the globe in imaging procedures that diagnose heart disease, cancer and other life-threatening conditions. The isotopes are injected into patients and emit gamma rays that can be tracked in the body, letting

— CONTINUED ON PAGE 4

Internships fuel research for Puerto Rico engineering students

Program connects students from five Hispanic-serving institutions with Sandia researchers

By ***Melissae Fellet***

For Edgardo Desarden Carrero, a student in the newly created electrical engineering doctoral program at the University of Puerto Rico, Mayagüez, his two summers working in resilient energy systems research at Sandia were his first internship. He is an unusual student in that he is also a professor of electrical engineering technology at the University of Puerto Rico, Aguadilla.

"I've been amazed at all the opportunities here to access equipment and interact with engineers who have a variety of backgrounds," Desarden Carrero said.

The NNSA-sponsored Consortium for Integrating Energy Systems in Engineering and Science Education internship program connects engineering students from five Hispanic-serving institutions, including UPRM, with research at Sandia and the National Energy Technology Laboratory in Morgantown, West Virginia. The program has recently been extended through next summer.

From 2017 to 2019, 41 students have worked in labs around Sandia, in departments including geomechanics and energy systems. Often, their internship work becomes the focus of their graduate research and an opportunity for long-lasting relationships. So far, 10 students have become year-round interns at Sandia.

"For us, this program is critical to broaden our reach in terms of where we can get well educated students and Hispanic engineers," said Tito Bonano, a senior manager at Sandia who helped forge the partnership with UPRM. He was born and raised in Puerto Rico, went to school at UPRM and is now a member of the industrial advisory board of the university's engineering school.

FUELING CONNECTIONS — Edgardo Desarden Carrero, right, talks with Melvin Lugo Alvarez, both interns from the University of Puerto Rico, Mayagüez, studying resilient energy systems at Sandia. **Photo courtesy of Edgardo Desarden Carrero**

According to the American Society for Engineering Education, UPRM awarded 528 undergraduate engineering degrees in 2017, second in the United States in terms of graduating Hispanic engineers. An agreement between Sandia and UPRM under development will ensure the institutions can continue to collaborate on projects.

"Our students are the promise of the present and the future," said UPRM Chancellor Agustín Rullán-Toro. "We are always very proud to say they are the best of the best. They are talented young people eager to learn more. They have immense creative abilities and the passion to move forward. That's why the combination of these two elements — the opportunities Sandia provides, plus the willingness of our students — has been a perfect recipe for success."

Simplifying equipment

While at Sandia last year, Desarden Carrero met Sigifredo Gonzalez, an electrical engineer in the Distributed Energy Technologies Laboratory. Gonzalez introduced Desarden Carrero to the

— CONTINUED ON PAGE 6

LAB**NEWS** Notes

State of the Labs

Creating the future of national and global security

By ***Kristen Meub***

A rocket-propelled semi on the sled track, tricky plutonium measurements at Z, intellectual leadership of nuclear deterrence and opportunities for early career staff to put payloads on rockets — these are just a few accomplishments that Labs Director Steve Younger highlighted during his State of the Labs address on Oct. 30.

As he began his talk, Steve encouraged Sandians to pause and think about what we've accomplished and where Sandia is headed. Videos highlighting the HOT SHOT program, the Mobile Guardian Transporter prototype and ducted fuel injection led the address.

Steve then spoke about Sandia's nuclear deterrence program, praising the team for leaning in and addressing a scheduling issue, and beyond that, for helping Sandia take intellectual leadership in defining the future of nuclear deterrence. "This is important, because that's why we were created," he said.

Steve spoke about accomplishments at Sandia's Z machine and in crude oil transportation safety, the P19 program, small business procurement goals, assisting a London airport with counter-unmanned aircraft systems, legal risk reduction and possible gross receipts tax savings. He also praised Sandia's excellent score on the Cyber Command Readiness Inspection and the numerous local and national awards won by Sandians.

"I will tell you that I don't think a day goes by that there isn't a Sandia product on the president's desk, because what you do is incredibly important," Steve said. "There are folks laboring away behind three cipher locks, and you may never know what they do, but I can tell you that they sometimes have an amazing impact, not just on national security, but on global security.

EXCEPTIONAL SERVICE — Sandia Labs Director Steve Younger highlighted workforce accomplishments during his annual State of the Labs address on Oct. 30. **Photo by Randy Montoya**

"What makes me so proud to be a Sandian is the impact you all have on the planet. It is absolutely amazing," he said.

The address also covered Sandia's recent hiring increase and current workforce distribution in years of service and age. Steve shared that the Labs has achieved improvements in minority representation in management, women in R&D roles and in the hiring rate for individuals with disabilities.

The end of the talk covered Sandia's goals, objectives and priorities for the future, including a look at the seven priorities that will advance from concepts to proposals this fiscal year.

"We are creating the future of national security; we are creating the future of global security," Steve said. "We are doing that by assuring a safe and reliable nuclear deterrent, safeguarding homeland and global security, creating energy technologies for the future and enabling a diverse and productive workforce. What did we do this year, and what will we do in the future? Exceptional service in the national interest."

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LAB**NEWS** Notes

EDITOR'S NOTE: Lab News welcomes guest columnists who wish to tell their own "Sandia story" or offer their observations on life at the Labs or on science and technology in the news. If you have a column (500-800 words) or an idea to submit, contact Lab News editor Tim Deshler at tadeshl@sandia.gov.

Tracy Vogler named APS Fellow

Story and photos by ***Michael E. Langley***

Tracy Vogler

Tracy Vogler has been elected Fellow of the American Physical Society by the organization's Topical Group on Shock Compression of Condensed Matter.

Tracy was recognized for "landmark contributions to the basic understanding of shock propagation in metals, ceramics and granular materials; for sustained service to the APS Topical Group on Shock Compression of Condensed Matter; and for leadership in the science community."

Tracy earned a bachelor of science degree in mechanics from theVirginia Polytechnic Institute in 1992, a master's in aeronautics and astronautics from the Massachusetts Institute of Technology in 1994, and a doctorate in mechanics from the University of Texas at Austin in 1999. After 18 months at the Army Research Laboratory in Maryland, he joined Sandia in 2001 to study experimental shock physics.

"I find it incredibly exciting because these things happen in microseconds," Tracy said of the shock waves that come from explosions and impacts. "They are not readily observable, and the challenge of mentally conceptualizing these events and how to measure them is very stimulating. I also appreciate that what I do is relevant to the country."

Tracy spent seven years in Albuquerque before moving to Sandia's Livermore campus. He found out just days before the late October announcement that he was named an APS Fellow. His mentor and former Sandian, Lalit Chhabildas, and former Sandia manager Jim Asay had begun Tracy's nomination earlier this year.

"They worked to put together the application," Tracy said. "I am so grateful to Lalit and Jim for their guidance and friendship over the years and for what they did to have me named an APS Fellow. It's a great honor to follow in their footsteps and those of the other Sandians — Lynn Barker, Dennis Grady, Dennis Hayes — from the previous generation who are APS Fellows and pioneers in the field of shock physics."

DNA science reveals hidden family connection

Sandia/California systems engineer never imagined an email would change his life forever

FAMILY HISTORY — Sandia/California systems engineer Don Bender, right, hosted his sister, Freedom Baird, at his home just months after discovering their connection.

Photos courtesy of Don Bender

By ***Michael Ellis Langley***

Imagine waking up one day, certain that you knew everything you needed to know about yourself and your family, only to discover you actually have a sibling you never knew of, with whom you share an almost mystical number of similarities.

Donald Bender was born in New York City in October 1957, and was immediately put up for adoption. In December of that year, he arrived at his adopted parents' home.

"Adoption was a terrific thing for me," Don said. "I was raised by people who loved me and were ready to raise a child."

Don grew up in Lagrangeville, in the Hudson River Valley of New York. He earned a bachelor's degree in 1979 and a master of science in 1983, both from the Massachusetts Institute of Technology. He now works at Sandia/California.

Surprising test results

As an adult, Don said he was not particularly interested in finding his birth family. Then late last year, he took a commercial DNA test to learn his ethnic heritage. He got the results on March 9.

"My ethnicity wasn't particularly interesting. But the shocking thing was it identified Freedom Baird as an immediate family member," Don said.

Without meaning to, he had found a sister.

"So I looked her up within minutes of getting the results and emailed her immediately," Don said.

At her home in Cambridge, Massachusetts, Baird received Don's email minutes after receiving one from the commercial DNA company they had both used.

"So I read that and my first thought was, 'Well this is a goof. Someone's just messing with me,'" Baird said, adding that she responded politely, but asked if it was a prank.

"He emailed me back and said 'no, this isn't a prank, this is real,'" she said. "He gave me his name and address, and I said, 'Would you mind sending me a few photos?' He sent me photos of himself and his sons. That was when my mind was completely blown."

For Baird, the similarities were incredibly personal.

"He looks like everyone in my family," she said. "Don looks like me. He looks like my grandfather. There's no question he's a relative. I kept staring at his picture. I just couldn't put it together."

Don understood her reaction.

"This caught Freedom completely by surprise," he said. "She did not know I existed and was getting this information that was kind of unbelievable."

"I guess it's the emotional trajectory you take when you experience any big shock," Baird said. "So at first, as I was sitting on my couch looking at these photos, and Don and I were exchanging emails, it was almost like a state of alarm. I kept asking myself, 'Is this real?'"

More than just physical similarities

Don and Baird immediately began to exchange long emails and Skype video calls. Don said he was astonished by the number of things the two had in common.

"Obscure things," he said. "Movies that no one else would like that we had each watched 10 times, that kind of thing. The sheer volume, in every different aspect of our lives: we watch a certain type of news program every day; we order the same dish at a Mexican restaurant consistently; we have the same shape of toes, which are a little unusual. It just hasn't ended."

Baird agreed.

"We actually started making a list of all the things we have in common, and it's just crazy," she said. "We are both outdoorsy. He hikes and I am a rock climber. We both enjoy winter sports — no one else in our families did. And we both read the same three newspapers every day."

Baird had also graduated from MIT, earning her master of science degree 14 years after her brother, so when Don shared with her his birthdate and birthname, which was Daniel, she went into research mode.

"I took those two data points, and I went into the New York City birth records," Baird said. "I searched for all babies with the last name Baird in his birth year, 1957, and I found him. There was 'Daniel Baird' and his exact date of birth. I knew it was him. I took a screenshot, highlighted the record in yellow and sent it to him and said, 'I found you.'"

The meeting

After that, Don needed to meet his sister in person.

"By the beginning of May, I flew to Cambridge to meet her and her family in person for the first time," he said.

"We had a wonderful time getting to know each other," Baird said about that meeting. "We had a big meal with lots of cousins and shared a lot of stories about both families."

A few weeks later, Don flew back to Cambridge, and the siblings attended the MIT alumni reunion together, walking across campus pointing out areas that were important to each of them.

Don later took Baird to Lagrangeville to show her where he grew up.

"Then over Labor Day, she and my niece and nephew came out to the Bay Area," he said. "I showed them my house and took them on a tour of Northern California. In a few weeks, Baird and I are going to meet in New York City and she's going to show me where she grew up."

Adoption reunions: Different for everyone

The process Don and his sister have gone through has been deeply rewarding for both of them, but both recognize that may not be everyone's experience. Baird recommends getting as much information as possible before moving forward.

"Adoption reunion is a process, and everyone goes through it in their own way," she said. "One of the things that helped a lot was that once I realized Don was my brother, I did a bunch of research about these reunions, got a couple of books and talked to a dear friend who is adopted. All of that helped me shepherd myself and Don and everyone through this experience."

For his part, Don keeps finding experiences that take a deeper meaning than he would have thought possible.

MEMORY LANE — Don grew up in Lagrangeville, in the Hudson River Valley of New York.

"At my doctor's office recently, I brought my entire family medical history for her to enter," he said. "There had been one word under family medical history: 'adopted.' I just brought her the information, she typed it all in and then deleted 'adopted.' So I'm at the doctor's office experiencing the feels."

Take a frozen turkey to work day

TRADITION OF GIVING — Generous Sandians brought more than 250 frozen turkeys to work on Nov. 19 for the Labs' annual Take a Frozen Turkey to Work Day. Community Involvement team members and volunteers collected the turkeys at drive-through locations around the Labs and delivered them to the Roadrunner Food Bank to help feed families in need.

Photos by Katrina Wagner

Two Sandians honored at annual SWE awards

*By **Laura Sowko***
*Photos by **Lonnie Anderson***

Sandia scientists Blythe Clark and Karen Devine were honored at the 2019 Society of Women Engineers awards ceremony in Anaheim, California. The annual event recognizes "the successes of individuals who enhance the engineering profession and advocate for women in engineering through contributions to industry, education and the community."

GAME CHANGER — Sandia manager Blythe G. Clark earned a 2019 Advocating Women in Engineering Award at the Society of Women Engineers' annual ceremony in November.

Blythe G. Clark

Sandia manager Blythe G. Clark earned a 2019 SWE Advocating Women in Engineering Award at the November ceremony. Blythe joined Sandia in 2008 and has led the materials characterization and performance organization for the past four years. She has spent her research career leveraging her expertise in advanced electron-microscopy-based analyses to identify and predict atomic-scale processes critical to advancing the fields of nanomechanics and nanostructured metals.

Blythe's work on thermally and mechanically stable platinum-gold nanocrystalline coatings has been a game changer, with her team realizing leading-edge, ultra-wear-resistant electrical contacts. "We believed that thermally stable binary nanocrystalline alloys could have remarkable mechanical properties," she said.

Based on initial collaborator predictions, Blythe selected a platinum-gold alloy as a material that could work. However, after additional calculations, concerns were raised that the material may be "nothing special." After careful consideration, Blythe decided to proceed. "It could have been a failure, but I took the risk, and it was amazing to see it pay off," she said. "It was exciting to see how cool that material is." Sandia scientist Nicolas Argibay continued the work to engineer a platinum gold alloy that may be the most wear-resistant metal in the world.

Blythe's devotion to her work at Sandia is equaled by her enthusiasm in advocating for inclusion and diversity. As a staff member, Blythe joined a peer mentoring group. Her group read Anne-Marie Slaughter's article, "Why women still can't have it all," which sparked a deep interest for Blythe in unconscious gender bias, leading her to read extensively on the topic and to work to identify solutions to increase workplace inclusion and diversity. Through the Sandia Women's Action Network, which she co-chaired from 2017 to 2019, Blythe led efforts to influence policy changes and obtain strategic commitments from Sandia leadership to mitigate bias in recruiting, hiring, development and retention.

Recently, Blythe co-authored an article with Olivia Underwood, "Mitigating implicit bias as a leader," for the Minerals, Metals & Materials Society. In the article, Blythe and Olivia point out that "the overwhelming evidence shows that we need diverse teams with diverse thoughts: diversity of thought that comes not only from different education backgrounds, but from different upbringings, different ethnicities, different genders and different life experiences." The article identifies several ways for leaders to increase inclusion and leverage diversity.

"When I think about the charge of science and engineering — being able to create the future and solve problems that haven't even been conceived yet — our job is to solve the most difficult problems in the world with the most creative and innovative approaches possible," she said. "The only way I know to get there is to leverage diversity of thought on teams and make that into something special. When you bounce ideas off each other and get broad input is often when the magic happens."

Karen Devine

Sandia researcher Karen Devine earned a 2019 SWE Prism Award at the annual event. Karen began her Sandia career as a summer graduate intern and then joined Sandia in 1994, becoming a full-time employee in 1996. She wears many hats inside and outside Sandia, including computer science researcher, project lead, customer liaison, mentor, mother and STEM outreach advocate.

STEM CHAMPION — Sandia researcher Karen Devine earned a 2019 Prism Award at the Society of Women Engineers' annual ceremony in November.

In 2001, Karen pioneered a process for releasing open-source software. The release of open-source software enables free exchange of ideas, promotes reproducible results and reduces duplication of effort in the research community.

"One of the things we did early was to work with the tech transfer people and the export control people to create a way to release software," she said. Prior to her work, few projects released open-source software. Now the DOE Office of Science requires open-source software release for many new proposals.

The first test case for Sandia's open-source release process was Zoltan, a production tool for engineering and a research test-bed for new algorithms that improve parallel performance. Karen designed and has supported Zoltan for more than 15 years. The software has been downloaded more than 4,500 times since its release. Currently, Karen is investigating ways to leverage DOE investments in high-performance computing to speed development and reduce the cost of solutions for extreme-scale data analytics.

When interviewing candidates, Karen emphasizes the importance of Sandia's work. "People really use what we write, and what we write is really important," she said. "We can't compete with employers offering ping pong tables and free food, but what I do feels more important. I think that's where Sandia really has an advantage."

Karen is active in the research community through her leadership in technical program committees, conferences and professional societies. In addition to mentoring junior staff members, she has mentored 17 students and postdoctoral students.

Karen also promotes math fluency as a volunteer for Sandia's Family Math Night program, and has organized events (aligned with the Association of Women in Mathematics' annual essay contest) that connect middle school girls with Sandia women in STEM. At one event, the girls' teacher commented on the positive impact of seeing a whole room of women in STEM, rather than just one or two.

Karen hopes to leverage her Prism Award to increase hiring and STEM opportunities. "I hope I can raise a little visibility for Sandia," she said.

Medical-isotope reactor

CONTINUED FROM PAGE 1

physicians create images of the spread of a disease. They also decay quickly so patients are exposed to little radiation.

Building the reactor is important because there are a limited number in the world that primarily produce molybdenum-99, or moly-99, which decays to technetium-99m, a short-lived isotope that can be used to make individual patient doses, said Wagner. Some of those reactors have unplanned outages, causing shortages and price spikes.

Sandia's concept is to produce moly-99 with a small, 2-megawatt reactor, which would require less maintenance than larger reactors. The technology, which uses low-enriched uranium, could help produce a reliable domestic supply of moly-99 without the use of highly-enriched uranium. Eden was able to demonstrate that they had a funding plan and enough experience to obtain an exclusive license for the technology.

"This has been a stellar example of transferring Sandia technology," said Sandia business development specialist Bob Westervelt, who worked on licensing the concept. "The team that worked on this from Sandia was really committed to making this work, and Eden is making it possible for the technology to move forward. Everyone involved put in a lot of effort over many years to make this a success."

The isotope is used for 40 million nuclear medicine diagnostic procedures each year, Wagner said. In the U.S. alone, the isotope is used for more than 40,000 medical diagnostic procedures each day, according to Sandia senior manager Matt Burger.

The purpose for producing the isotopes and the dedication to this issue are deeper than science and solving a problem, Wagner said.

"This type of technology has the ability to affect millions of patients worldwide," he said. "I think what continuously drives us is that unless someone solves the supply issue, a lot of patients will be adversely impacted. At the end of the day, a lot of people will benefit, but they won't know our names. It's that internal satisfaction of making a difference that drives us."

Alloy, catalyst and zero-emissions vessel research

In addition to this effort with Eden, the Federal Laboratory Consortium recognized three other projects involving Sandia in the Mid-Continent and Far West regions.

- One partnership earned a Notable Technology Development Award for a breakthrough in using detergent to make uniform powder catalysts that outperform commercial varieties used to kick-start chemical reactions. The catalytic compounds could be used in many applications, including environmental clean-up and cancer treatment.
- Labs' researchers earned a Notable Technology Development Award for engineering the world's most wear-resistant alloy, which has gained tech transfer interest from companies in several sectors. The alloy is 100 times more durable than high-strength steel and could make electronics of all sizes and across many industries more cost-effective, long-lasting and dependable.
- Sandia received an Outstanding Partnership Award for research on a zero-emissions research vessel. A Sandia report showed it is technically and economically feasible to build a vessel that meets marine regulations and doesn't pollute the air or ocean.

"We are proud to celebrate and recognize our industry partnerships, technology and technology transfer efforts that support Sandia's missions," said Jackie Kerby Moore, Sandia's technology and economic development manager and the Labs' Federal Laboratory Consortium representative. "These technologies are being developed and transferred to the private sector and will create many business opportunities."

Sandia winners were recognized at a recent awards ceremony at the FLC Far West/Mid-Continent Regional Meeting in Livermore, California.

Power plants get watered down

By **Melissae Fellet**

Electricity production is one of the industries that uses the most water in the country each day. Researchers at Sandia are helping the largest power plant in the United States identify the most efficient and cost-effective strategies to reduce water use. They have developed a first-of-its-kind comprehensive system dynamics analysis that can show power plants which wet cooling systems can save them money.

The analysis could eventually be used at other plants as federal regulators begin to reduce the power industry's allowed water supply. The researchers have also redesigned and patented an air-cooling system to make waterless cooling more energy efficient and possible over a wider range of operating conditions.

The Palo Verde Nuclear Generating Station near Phoenix, Arizona, converts heat from nuclear reactions into electricity. The heat boils water, creating steam that drives turbine generators. Steam leaving a turbine must be cooled and condensed before it is reused.

More than 40% of the country's water is used for wet cooling at power plants. Typically, large thermoelectric power plants are located near lakes or rivers so that operators can draw a regulated amount of water, run it through a condenser to cool steam leaving the turbines, and discharge roughly the same amount they withdrew.

The Palo Verde plant has limited access to water because it is in the middle of a desert. Its cooling water is treated wastewater, which is becoming increasingly expensive as other customers — who are willing to pay higher prices for water — emerge. To curb rising costs, operators want to reduce the plant's water use by about 9 million gallons a day. Annually, that savings is roughly equivalent to a 16-square-mile pool of water one foot deep, said Sandia nuclear engineer Bobby Middleton.

Other thermoelectric power plants will be looking for water-saving approaches in the future as rising populations, increased per capita energy usage and potential federal regulations reduce supplies of cooling water. The Sandia analysis could be used to save water at these power plants, too, whether they run on coal, natural gas or nuclear energy.

"We jumped at the opportunity to tackle this problem for Palo Verde because solutions that work for Palo Verde could also work for other plants, too," Bobby said.

Emerging cooling technologies

To reduce the plant's water use, operators at Palo Verde first looked at commercially available solutions. When they realized that nothing available could meet their needs, they turned to Sandia to help identify which cooling systems under development might eventually offer the greatest water savings.

To evaluate different emerging technologies, Bobby developed software that combines the physics of the cooling process — such as fluid flow, heat transfer, atmospheric evaporation and water treatment — with the financial impact of different solutions. Sometimes, a certain technology saves a plant money through increased efficiency; other times, reductions in water use deliver overall cost savings.

"No one has created a system dynamics analysis that simultaneously considers all these factors before," Bobby said. "It helps us predict the benefits we might see from a particular technology so that we spend time only testing the most promising approaches."

The wastewater that arrives at Palo Verde contains silica, calcium, magnesium and phosphate ions. These salts concentrate as the cooling water evaporates in the cooling system, possibly forming new minerals that might clog the cooling towers. Currently, operators add lime, soda ash and acid to the wastewater before it enters the cooling tower to reduce the possibility of mineral formation.

Bobby and Sandia chemist Patrick Brady are using the model to identify less expensive ways to remove ions at different points in the cooling cycle. For example, the Sandia researchers are examining the feasibility of desalinating discharged cooling water so that it can be reused. Otherwise, the water is too salty for reuse and must be evaporated from large ponds.

The researchers have finished the first phase of the project, developing the analysis software. The next phase involves using the software to identify the most promising water saving technologies, including alternative water treatment approaches, as well as dry and hybrid coolers that use supercritical carbon dioxide instead of the standard refrigerants used in commercial technology. The final phase of the project involves testing the most promising technology in a laboratory setting in the hope that a cost-effective solution can be installed at Palo Verde in 2026.

Efficient cooling without water

While evaluating effective cooling technologies, Sandia researchers also are working to improve existing solutions. Earlier this year, Bobby and his colleagues were awarded a patent for redesigning an air cooler to use supercritical carbon dioxide to transfer heat from steam to air. This change makes indirect dry cooling feasible over a wider range of conditions while increasing the system's efficiency.

Wet cooling systems such as those at Palo Verde have water-filled condensers to cool steam leaving the turbines. Direct dry cooling systems transfer heat from the steam directly to air; indirect dry cooling systems transfer heat from the steam to water then from the water to air. Current commercially available systems designed to retrofit a power plant typically use a recirculating refrigerant instead of water to help transfer heat to air.

POWER COOLING — Sandia researcher Bobby Middleton, right, has developed a more efficient cooling system for power plants. Together with Patrick Brady, left, the researchers are also developing a first-of-its kind systems dynamics analysis to identify water-saving technologies for cooling at power plants. **Photo by Randy Montoya**

In these commercially available systems, the liquid refrigerant boils as it absorbs heat from the steam and condenses into a liquid as it loses that heat to air. This change from liquid to gas releases energy that causes the refrigerant to circulate naturally through a heat exchanger.

The new indirect cooler design uses supercritical carbon dioxide instead of a refrigerant. Here's how it works: Above a certain pressure and temperature, carbon dioxide becomes a supercritical fluid. This means the CO_2 acts as a liquid below the critical temperature and as a gas above the critical temperature. However, at no point is the fluid a two-phase fluid; it does not boil. Because one fluid can change from a liquid to a gas without boiling, a supercritical fluid can transfer heat over a wider temperature range than a sub-critical fluid (such as the R134a used in current technologies).

The performance benefits with this design come from the amount of air needed to refresh the supercritical carbon dioxide for another round of cooling. A heat exchanger with supercritical carbon dioxide uses less air to cool water to the same temperature as a traditional dry cooler with a sub-critical refrigerant; it can also make water cooler using the same amount of air. Both impacts improve the overall energy efficiency for the cooling process.

"The expanded operating conditions also mean that there are more times of the year plants can use dry cooling," Bobby said.

The researchers plan to test Sandia's design against state-of-the-art, commercially available technology, and they are currently analyzing it as a potential solution for the Palo Verde plant.

Due to the decreasing availability of water, what was once the cheapest resource for thermoelectric power plants is quickly becoming one of the most expensive aspects of electricity production.

"Water saving technologies for energy production are critical for scientists and engineers to consider today," Patrick said.

New wind technology breathes life into turbine siting

By **Kelly Sullivan**

Sandia researchers Chris Kelley and David Maniaci and former Sandian Brian R. Resor have developed a wind turbine blade design that would allow for the closer placement of turbines, thanks to a faster dissipating wake.

"The blades of each turbine create a wake, slowing down the wind and stirring it," said co-inventor Chris, who works in Sandia's wind energy department. "The axial induction distribution, an important aerodynamic parameter in the new design, dictates how much the air slows down along the radius of the rotor when air passes through the rotor plane. The induction of this innovative blade design leads to a less stable wake that disappears faster."

Chris said the innovation would allow for siting turbines closer together to decrease the amount of electrical lines and roads needed to connect them, which would be of particular interest to wind farm owners.

"Subsequent research could include determining exactly how the wake is made less stable, and how it could be integrated into commercial wind farms," he said.

Next steps for the researchers include taking their idea into the field by partnering with manufacturers and owners to demonstrate the concept at a commercial wind farm. A field experiment would measure how much the new blades would reduce plant energy losses due to turbine-turbine interaction of wakes.

Chris said the idea for the patent originated during the National Rotor Testbed project, which sought to design new wind turbine blades with a focus on wake research at Sandia's Scaled Wind Farm Technology facility in Lubbock, Texas.

"Initially we were designing a new blade set for our test site," he said, when they realized they could change the persistence of the wake. Based on their vortex code simulations, the blade design changed the character of the wake with minimal effect on the efficiency of each turbine.

TURN, TURN, TURN — Three wind turbines at Sandia's SWiFT facility are used to study the wake interaction of turbines. **Photo courtesy of Chris Kelley**

"Working in wind energy at Sandia has been rewarding," Chris said, "because I see a direct impact of our research to reducing the cost and improving the reliability of wind energy for the electrical grid."

The researchers were recently issued a patent for their work, "Wind Turbine Blades, Wind Turbines and Wind Farms Having Increased Power Output."

To learn more about wind energy, search SWiFT on energy.sandia.gov.

Puerto Rico energy interns

CONTINUED FROM PAGE 1

concept of islanding, a topic that is now the focus of his doctoral research.

Islanding happens when a power system, such as solar panels or a microgrid, continues to provide energy even when disconnected from the main electrical grid. Islanded systems are dangerous to utility workers who are not expecting live wires during repairs, and they also pose safety risks when power returns to the main grid.

To address this problem, electrical engineers want the inverter, the component that transforms direct current produced by some islanded systems to alternating current on the grid, to detect a power outage and disconnect itself.

Desarden Carrero is developing a virtual tool to test whether the inverter's software to detect unintentional islanding complies with industry standards; however, few labs have the large equipment needed for his tests, so he's developing a versatile system that is smaller and hopefully less expensive than current systems.

The Power Hardware in the Loop system involves three major components: an inverter, a power amplifier and a computer. Together, these components are able to emulate different scenarios required by the standards.

Last summer, Desarden Carrero developed the computer controls for the simulated loads. Now he's testing the system's accuracy.

"Ideally the smaller size and reduced cost could help make this equipment available to universities that do not have space for large physical equipment," he said.

Varied applications

Daniel Lizama Molina, a doctoral student in mechanical engineering at UPRM, came to Sandia with the internship program in the summers of 2017 and 2018. During both visits, he worked in the geomechanics department with geoscientist Hongkyu Yoon.

ENGINEERING OPPORTUNITIES — Daniel Lizama Molina is a year-round intern from the University of Puerto Rico, Mayagüez, studying geomechanics at Sandia.
Photo by Randy Montoya

"I've worked on a different project each time I've been here," Lizama Molina said. His first project involved three-dimensional simulations of mechanical properties of shale rock, information that is important for oil and gas extraction. "Now my project involves my specialty, machine learning and signal analysis," he said.

At UPRM, Lizama Molina took several classes about analyzing the structure of signals from brain wave scans or information in each pixel of an optical or thermal image. Now, as a year-round intern, he's applying that knowledge to challenges in geomechanics, particularly low-frequency sound signals produced by moving rocks. Lizama Molina is using software for acoustic wave signal analysis, much like programs for voice recognition, to analyze seismic event data.

Lizama Molina continues to teach his classes and supervise his students at UPRM, though the meetings happen online now. "I'm able to use the project management skills I've learned at Sandia for that work too," he said.

Diversifying the future workforce

The Consortium for Integrating Energy Systems in Engineering and Science Education internship program is part of NNSA's Minority Serving Institutions Partnership Program, which aims to help develop a diverse science and engineering workforce through internships and collaborations at national labs.

Sandia offers three internship opportunities that are part of this NNSA program. CIESESE works with primarily Hispanic-serving institutions, the Consortium Enabling Cybersecurity Opportunities & Research works with Historically Black Colleges and Universities, and the Tribal Colleges and Universities/American Indian Higher Education Consortium advanced manufacturing project works with tribal colleges.

The institutional partners for the CIESESE program include UPRM, the University of New Mexico, the University of Texas at El Paso and Miami Dade College. Student interns participating in the program work at Sandia or the National Energy Technology Laboratory. This year, 16 students and four faculty fellows participated.

Sandia is also developing a 10-year Cooperative Research and Development Agreement with UPRM so that the institutions can collaborate on projects.

SANDIA CLASSIFIED ADS

***NOTE:** The classified ad deadline for the Jan. 3, 2020, Lab News is noon Monday, Dec. 16.*

AD SUBMISSION GUIDELINES

AD SUBMISSION DEADLINE: Friday noon before the week of publication unless changed by holiday.

Questions to Michelle Fleming at 505-844-4902.

Submit by one of the following methods:

- **EMAIL:** Michelle Fleming (classads@sandia.gov)
- **FAX:** 505-844-0645
- **MAIL:** MS1468 (Dept. 3651)
- **INTERNAL WEB:** Click on the News Tab at the top of the Techweb homepage. At the bottom of the NewsCenter page, click the **"Submit a Classified Ad"** button and complete the form.

Due to space constraints, ads will be printed on a first-come, first-served basis.

MISCELLANEOUS

ROTOTILLER, Troy Bilt, front tine, used twice, 2 yrs. old, $150; insulated dog house, $50; Bushnell trail cameras, 2, $100/both. Halford, vhalford56@gmail.com.

PORTABLE PLANER, Ryobi, 13-in., high-spd. reversible blades, auto feed, 120V/15A, 2-hp, 6-in. max planing height, manual, $100. Glaser, 505-228-6742.

ANTIQUE/VINTAGE CLOCKS, mechanically driven, wall/mantle/floor, serviced, working, nice warm additions to any home. Ross, 505-332-0659.

NUWAVE OVEN, white, some accessories, excellent condition, great for dorm or beginning apt. life, $30. Garner, 505-269-3350.

TONNEAU COVER, for '09-'13 Subaru Forester, $125 OBO. Clayton, 505-221-4918.

WASHER & GAS DRYER, Kenmore, front-load, metallic gray, energy efficient, dryer needs repair, $200/both OBO. Montoya, 505-342-0043.

STRESS LESS COUCH, TEMA, $2,000, contact for photos. Boddington, slhanks@comcast.net or 505-508-5668, leave message.

DIECAST METAL TOYS, in boxes, new condition, many collectors' editions, various prices, photos available. Hanks, 505-249-1931, call or text.

CANON G7X MARK II, point & shoot camera, used 3 times, new condition, w/extra battery & tripod, $500 OBO. Raether, 505-550-9649.

RANGE TOP/OVEN, gas, used, $100; refrigerator/freezer, used, $100. Cisar, 505-899-9116.

GIFT CARD, Carnival Cruise, brand new, worth $500, asking $450. Ma, 505-715-2382.

FLOOR JACK, unopened, 3-ton, low profile, from Harbor Freight, $100. Wolfgang, 505-414-1483.

ESCAPE TO MARGARITAVILLE, Popejoy, Sun., March 15, 1 p.m., balcony seating, aisle & adjacent, $50/pair. Witt, 505-415-2188.

ELLIPTICAL MACHINE, LifeFitness 9500 HR, rarely used, good condition, you transport, $350 OBO. Alba, 505-205-4831.

HUMIDIFIER, Sunbeam, model 661, Ultrasonic Cool Spray, 1-gal. water reservoir, distilled/filter water recommended, original instructions, $35. Griffee, 505-280-0082.

EXERCISE BIKE, training bike, Tour de France, ProForm TDF Pro 5.0, purchased in 2016, ridden minimally, $750. Ballantine, marissadevan@gmail.com.

FIREWOOD, mixed/seasoned/split, will deliver, $140/truckload, $225/6' x 10' trailer load. Vigil, 505-480-9749.

TRANSPORTATION

'15 HONDA CRV EX, for parts, gray, 650 miles, seats, console, right side, rear end, lines/cables, engine/transmission (6K miles), $1,000. Mills, 505-515-8270.

'16 TOYOTA COROLLA LE, Eco model, low mileage, great condition. Deere, 505-281-4384.

'06 CHEVY AVALANCHE 1500 LT, 4WD, great condition, 172K miles, $6,900 OBO. Hidalgo, 505-573-6952.

'03 JEEP WRANGLER SPORT, soft top, dark blue, new tires, clutch & radio, 109K miles, runs great, $8,999. Ehasz, 505-270-1923.

'02 NISSAN PATHFINDER LE, clean title, 2nd owner, 170,734 miles, contact for details & photos. Flores, 505-280-1782, ask for Mike.

'03 BUICK LeSABRE CUSTOM, metallic blue, 58K miles, very good condition, $3,300. Williams, 505-271-4902.

RECREATION

'00 STAR CRAFT, pop-up cab over camper, refrigerator, heater, cook top, gas or electric, AC, fits 7-ft. truck bed, $2,000. Hibray, 505-821-3455.

MOUNTAIN BIKE, 29er XC, XL 2018 Diamondback Overdrive Carbon Pro, tubeless, Sram GX, great condition, $1,100 OBO. Beckett, 480-332-3748, ask for Justin.

REAL ESTATE

3-BDR. HOME, 2 baths, ~1,325-sq. ft., 2-car garage, nice, quiet gated community, partial views of Sandias, $168,000. Stauffacher, 505-369-9191.

3-BDR. HOME, 2 baths, ~1,750-sq. ft., new roof, electrical & other upgrades, desirable NE Heights/Academy area, $239,000 negotiable. Garves, 505-301-9445, ask for Christine.

WANTED

GOOD HOME, male Chow/Labrador mix, 2 yrs. old, needs loving home w/lots of space & attention. Snell, snellcolton@gmail.com.

AD RULES

1. Limit 18 words, including last name and home phone (web or email address counts as two or three words, depending on length).
2. Include organization and full name with ad submission.
3. Submit ad in writing. No phone-ins.
4. Type or print ad legibly; use accepted abbreviations.
5. One ad per issue.
6. The same ad may not run more than twice.
7. No "for rent" ads except for employees on temporary assignment.
8. No commercial ads.
9. For active Sandia members of the workforce and retired Sandians only.
10. Housing listed for sale is available without regard to race, creed, color or national origin.
11. Work wanted ads are limited to student-aged children of employees.
12. We reserve the right not to publish any ad that may be considered offensive or in poor taste.

Mileposts

New Mexico photos by Michelle Fleming
California photos by Randy Wong


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Mary Compton 30


Max Decker 30


Jeff Downs 30


Mike Dugger 30


Richard Hunt 30


Jeff Payne 30


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Todd Alam 25


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TC Hobson 25


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Kurt Larson 25


Anita Reiser 25


Laura Swiler 25


Laurel Taylor 25


Mike Valley 25


Dave Walsh 25


Vic Weiss 25


Michael Bawden 20


Wendy Crenshaw 20


Todd Dunivan 20

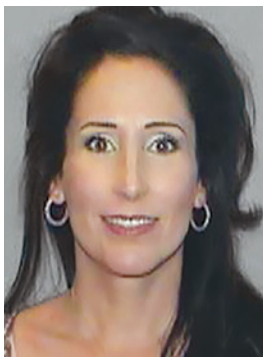

Anna Martens 20


Janet Montoya 20

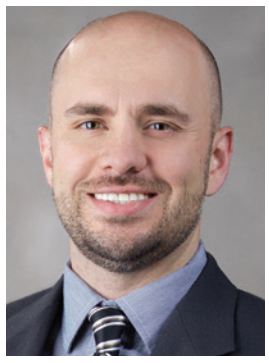

Max Saad 20


Sean Stroud 20


Judi Doolittle 15


Cindy Fulcher 15


Cynthia Graham 15


Justin Smith 15


Lourdes Valdez 15

Sandia teaches undergrads a lesson or two about cybersecurity

Students practice defending industrial control systems against Sandia red-teamers at CyberForce

By ***Troy Rummler***
Photos by ***Lonnie Anderson***

RISKY BUSINESS — Students gathered in downtown Albuquerque to sharpen their cybersecurity skills against Sandia cyber professionals posing as hackers.

Hundreds of cybersecurity professionals and college students gathered around the country Nov. 16 for a day of cyber wargames.

The event, DOE's roughly annual CyberForce Competition, was created to teach and inspire the next generation of cybersecurity professionals by giving them an opportunity to apply their skills against realistic problems. A global shortage of cybersecurity professionals could see 3.5 million vacant jobs by 2021, according to the research firm and media company Cybersecurity Ventures.

"We envision this competition to be a tool to assist our sector to close skills gaps and shortages of cybersecurity experts," said Karen S. Evans, Assistant Secretary for Cybersecurity, Energy Security, and Emergency Response, in a DOE press release.

In its second year hosting a competition site, Sandia worked with 10 teams at the Lobo Rainforest, the anchor building of downtown Albuquerque's Innovate ABQ complex.

Teams accumulated points by defending their systems against red-teamers like Sandia's Will Atkins, who has worked professionally in similar roles, helping government agencies and public utilities find weaknesses in their systems. Specialists from Los Alamos National Laboratory also came to support the competition.

Sandia relied on the varied experience of its volunteers to pull off the event.

"I can spot a problem in a system from a mile away, but as far as building systems, I'm not nearly as good at that," Will said, adding with a laugh, "I guess I would be a good movie critic."

Jeremy Gin, another Sandia cybersecurity expert, helped build and troubleshoot the systems students used, including a small mechanical device that periodically spun a set of wheels when the pretend facility was operating correctly. It failed or flashed a red light when the system was encountering a problem.

Traveling from Dallas, Texas, the team from Southern Methodist University won the top spot at the Albuquerque regional competition for the second year in a row. The University of Maryland, Baltimore County, team won the national competition.

Live together, die alone

In a new twist this year, CyberForce networked teams together from different locations, each representing a different facility: a power plant, a substation, a data center or a manufacturing facility.

In the real world, Jeremy said, "an adversary taking down a data center could force the security team to have to operate without a section of their network, a suite of tools or some data feeds, whereas an adversary taking down a substation or power generation facility could force the security team to have to operate on time-limited backup power or a temporary blackout."

If the wheels weren't turning on a team's device, they could open a chat channel with other teams to figure out if they were being attacked or if they were seeing the effects of an upstream problem. Teams were awarded points for sharing their vulnerabilities with others.

"They must understand how the whole ecosystem comes together and functions at a high level," said Jeremy, who was on hand during the competition to help students with questions. "At Sandia, as a team and enterprise, we do this every day."

Simulation focused on education

The exercise isn't a perfect analogy to real-world cybersecurity. The imposed time limit, Will said, meant he and his red-team partners didn't have time to launch subtler, more devious attacks, and blue-team students knew the attacks were coming, which obviously isn't true in life.

But in some ways, Will said, the imperfect emulation makes CyberForce a better educational tool. Overt attacks help students practice detecting suspicious activity and learn to assess it and respond appropriately. Part of the real challenge of cybersecurity, he said, is determining whether anomalous activity on a system is a targeted attack or a harmless probe.

Despite its artificialities, CyberForce succeeds in exposing students to ideas and experiences they wouldn't normally get as undergraduates.

"This competition is important to cybersecurity education because it calls attention to the unique functions, vulnerabilities and importance of industrial control systems compared to normal enterprise PCs and networks," Jeremy said.

"They're very good at what they do, but they're not experienced," Will said.

LEADING THE CHARGE — Sandia staff, including Nick Georgieff, center, provided technical support, and sometimes a little motivation, to make CyberForce a positive experience for the students.

ODE TO JOY — Following nine hours of competition, the Southern Methodist University team celebrated their first-place finish in the regional competition.